

CLAIMS

- 1 1. A dynamic gain flattening filter configured to receive an
2 optical signal, comprising:
3 a first filter stage including,
4 a first tunable coupling member;
5 a first differential delay with first and second tunable delay paths;
6 and
7 wherein the first tunable coupling member adjusts an amount of
8 power of the optical signal divided onto the first and second tunable delay
9 paths of the first differential delay.
- 1 2. The filter of claim 1, wherein the first differential delay
2 includes a fixed portion and a tunable portion.
- 1 3. The filter of claim 1, wherein the first differential delay
2 includes a first fixed differential delay and a first tunable differential delay
3 with respect to the first and second tunable delay paths.
- 1 4. The filter of claim 3, wherein the first fixed differential delay
2 sets a periodic variation in a power spectrum of the optical signal.
- 1 5. The filter of claim 3, wherein the first tunable differential
2 delay sets a phase of the periodic variation in the power spectrum of the
3 optical signal.
- 1 6. The filter of claim 3, wherein the first fixed differential delay
2 is positioned between the first tunable coupling member and the first tunable
3 differential delay.

1 7. The filter of claim 3, wherein the first tunable differential
2 delay is positioned between the first tunable coupling member and the first
3 fixed differential delay.

1 8. The filter of claim 1, further comprising:
2 a second stage including:
3 a second tunable coupling member ;
4 a second differential delay with first and second tunable
5 delay paths; and
6 wherein the second tunable coupling member adjusts an amount of
7 power of the optical signal divided onto the first and second tunable delay
8 paths of the second differential delay.

1 9. The filter of claim 8, wherein the second differential delay
2 includes a fixed portion and a tunable portion.

1 10. The filter of claim 8, wherein the second differential delay
2 includes a second fixed differential delay and a second tunable differential
3 delay with the first and second tunable delay paths.

1 11. The filter of claim 10, wherein the second fixed differential
2 delay sets a periodic variation in a power spectrum of the optical signal.

1 12. The filter of claim 10, wherein the second tunable differential
2 delay sets a phase of the periodic variation in the power spectrum of the
3 optical signal.

1 13. The filter of claim 10, wherein the second fixed differential
2 delay is positioned between the second tunable coupling member and the
3 second tunable differential delay.

1 14. The filter of claim 10, wherein the second tunable differential
2 delay is positioned between the second tunable coupling member and the
3 second fixed differential delay.

1 15. The filter of claim 3, wherein each of the differential delays
2 is a polarization dependent differential delay.

1 16. The filter of claim 3, wherein the first fixed differential delay
2 generates a time delay between first and second polarizations of the optical
3 signal.

1 17. The filter of claim 3, wherein the first tunable differential
2 delay changes an optical phase between first and second polarizations of the
3 optical signal.

1 18. The filter of claim 3, wherein the first tunable coupling
2 member is a polarization state transformer that transform the incoming
3 signal beam from one polarization state to a different polarization state.

1 19. The filter of claim 3, wherein the first tunable differential
2 delay modifies first and second polarizations of the optical signal with
3 different phase relationships.

1 20. The filter of claim 3, wherein the first tunable coupling
2 member includes first and second liquid crystal alignment members coupled
3 to a voltage source.

1 21. The filter of claim 20, wherein liquid crystals in the first and
2 second liquid crystal alignment members are orientated at different angles
3 with respect to each other.

1 22. The filter of claim 20 wherein liquid crystals in the first and
2 second liquid crystal alignment members are orientated at the same angle
3 with respect to each other.

1 23. The filter of claim 20, wherein liquid crystals in the first
2 liquid crystal alignment member are orientated orthogonal to liquid crystals
3 in the second liquid crystal alignment member.

1 24. The filter of claim 3, wherein the first tunable differential
2 delay includes first and second liquid crystal alignment members coupled to
3 a voltage application member.

1 25. The filter of claim 24, wherein liquid crystals in the first and
2 second liquid crystal alignment members are orientated at the same angle.

1 26. The filter of claim 24, wherein liquid crystals in the first and
2 second liquid crystal alignment members are orientated at different angles
3 with respect to each other..

1 27. The filter of claim 3, wherein at least one of the tunable
2 coupling members and the tunable differential delays is a liquid crystal
3 tuning element.

1 28. The filter of claim 3, wherein at least one of the tunable
2 coupling members and the tunable differential delays is a Faraday rotation
3 member.

1 29. The filter of claim 3, wherein at least one of the tunable
2 coupling members and the tunable differential delays is an electro-optic
3 member.

1 30. The filter of claim 3, wherein at least one of the tunable
2 coupling members and the tunable differential delays is a thermal tuning
3 member.

1 31. A dynamic gain flattening filter configured to receive an
2 optical signal, comprising:
3 a first filter stage including,
4 a first tunable coupling member;
5 a first differential delay with first and second tunable delay paths;
6 wherein the first tunable coupling member adjusts an amount of
7 power of the optical signal divided onto the first and second tunable delay
8 paths of the first differential delay and
9 a first polarization splitter positioned adjacent to the first filter stage,
10 the first polarization splitter splitting the optical signal into two orthogonal
11 polarizations.

1 32. The filter of claim 31, wherein the first differential delay
2 includes a fixed portion and a tunable portion.

1 33. The filter of claim 31, wherein the first differential delay
2 includes a first fixed differential delay and a first tunable differential delay
3 with the first and second tunable delay paths.

1 34. The filter of claim 33, wherein the first fixed differential
2 delay sets a periodic variation in a power spectrum of the optical signal.

1 35. The filter of claim 33, wherein the first tunable differential
2 delay sets a phase of the periodic variation in the power spectrum of the
3 optical signal.

1 36. The filter of claim 31, wherein the first polarization splitter is
2 a polarization walk-off crystal.

1 37. The filter of claim 31, wherein the first polarization splitter is
2 a polarization beam splitter.

1 38. The filter of claim 33, wherein the first fixed differential
2 delay is positioned between the first tunable coupling member and the first
3 tunable differential delay.

1 39. The filter of claim 33, wherein the first tunable differential
2 delay is positioned between the first tunable coupling member and the first
3 fixed differential delay.

1 40. The filter of claim 31, further comprising:
2 a first half-wave plate positioned between the first polarization
3 splitter and the first stage.

1 41. The filter of claim 31 , further comprising:
2 a second stage including:
3 a second tunable coupling member ;
4 a second differential delay with first and second tunable delay paths;
5 and
6 wherein the second tunable coupling member adjusts an amount of
7 power of the optical signal divided onto the first and second tunable delay
8 paths of the second differential delay.

1 42. The filter of claim 41, wherein the second differential delay
2 includes a fixed portion and a tunable portion.

1 43. The filter of claim 41, wherein the second differential delay
2 includes a second fixed differential delay and a second tunable differential
3 delay with the first and second tunable delay paths.

1 44. The filter of claim 43, wherein the second fixed differential
2 delay sets a periodic variation in a power spectrum of the optical signal.

1 45. The filter of claim 43, wherein the second tunable differential
2 delay sets a phase of the periodic variation in the power spectrum of the
3 optical signal.

1 46. The filter of claim 43, wherein the second fixed differential
2 delay is positioned between the second tunable coupling member and the
3 second tunable differential delay.

1 47. The filter of claim 43, wherein the second tunable differential
2 delay is positioned between the second tunable coupling member and the
3 second fixed differential delay.

1 48. The filter of claim 43, further comprising:
2 a second polarization splitter positioned adjacent to the first stage,
3 the second polarization splitter combining the two orthogonal polarizations.

1 49. The filter of claim 48, further comprising:
2 a first half-wave plate positioned between the first polarization
3 splitter and the first stage; and
4 a second half-wave plate positioned between the second walk-off
5 crystal and the second stage.

1 50. The filter of claim 48, wherein the first and second
2 orthogonal polarizations of the optical signal travel independently through
3 the first and second tunable differential delays.

1 51. The filter of claim 43, wherein each of the differential delays
2 is a polarization dependent differential delay.

1 52. The filter of claim 43, wherein the first fixed differential
2 delay generates a time differential delay between first and second
3 polarizations of the optical signal.

1 53. The filter of claim 43, wherein the first tunable differential
2 delay changes an optical phase between first and second polarizations of the
3 optical signal.

1 54. The filter of claim 43, wherein the first tunable coupling
2 member is a polarization state transformer that transform the incoming
3 signal beam from one polarization state to a different polarization state.

1 55. The filter of claim 43, wherein the first tunable differential
2 delay modifies first and second polarizations of the optical signal with
3 different phase relationships.

1 56. The filter of claim 43, wherein the first tunable coupling
2 member includes first and second liquid crystal alignment members coupled
3 to a voltage source.

1 57. The filter of claim 56, wherein liquid crystals in the first and
2 second liquid crystal alignment members are orientated at different angles
3 with respect to each other.

1 58. The filter of claim 56, wherein liquid crystals in the first
2 liquid crystal alignment member are orientated at 0 ° and the liquid crystals
3 in the second liquid crystal alignment member are orientated at 90 °.

1 59. The filter of claim 43, wherein the first tunable differential
2 delay includes first and second liquid crystal alignment members coupled to
3 a voltage application member.

1 60. The filter of claim 59, wherein liquid crystals in the first and
2 second liquid crystal alignment members are orientated at the same angle.

1 61. The filter of claim 59, wherein liquid crystals in the first and
2 second liquid crystal alignment members are orientated at an orthogonal
3 angle to each other.

1 62. The filter of claim 43, wherein each of the tunable coupling
2 members and the tunable differential delays is a liquid crystal tuning
3 element.

1 63. The filter of claim 43, wherein at least one of the tunable
2 coupling members and the tunable differential delays is a Faraday rotation
3 member.

1 64. The filter of claim 43, wherein at least one of the tunable
2 coupling members and the tunable differential delays is an electro-optic
3 member.

1 65. The filter of claim 43, wherein at least one of the tunable
2 coupling members and the tunable differential delays is a thermal tuning
3 member.